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# Variation of baroclinicity over the spring-neap cycle in the Sumjin River estuary, Korea

eun-byeol cho, yang-ki cho, gwang-ho seo, yong-jin tak, and bong-kuk kim
School of Earth and Environmental Sciences, Seoul National University, Seoul,Korea (yoyoro@snu.ac.kr)

Vertical velocity profiles and hydrography were intensively observed using Acoustic Doppler Current Profilers and CTD to understand the variation of baroclinicity over the spring-neap tidal cycle in the Sumjin River estuary, Korea. The Sumjin River estuary is a natural estuary in Korea. The river is 212km long, a drainage area is nearly 4,896km$^2$ and the yearly mean discharge is 86.3m$^3$/s. The Sumjin River estuary experiences a transition from partially- or well-mixed during spring tides (St $<$ 0.15), but stratified conditions during neap tides (St $>$ 0.32) based on the stratification parameter (St) which is the salinity difference between surface and bottom ($\delta$S) divided by the depth averaged salinity $<$S$>$.

The CTD observation cruises were taken at flood and ebb during neap tide and spring tide. The horizontal density gradient changes over fortnightly tidal cycle. The horizontal density gradient is small during neap tide. However it during spring tide dramatically increases about six to ten times larger than neap tide.

The mean flow in the Sumjin River estuary displayed typical estuarine circulation which the surface layer flows seaward and the bottom layer flows landward. However, the snapshots of the velocity profiles showed dramatic changes with the tide. Velocity shear is strong during spring tides when the tidal range was at a maximum, while velocity shear is weak during neap tides when the tidal range was at a minimum. The change of tidal range induces baroclinic variations.

An analytical model was applied to evaluate the effect of horizontal density on the velocity profile variation. The velocity profiles are determined by river discharge, horizontal density variations, and tide. Density variations act as a baroclinic pressure gradient, whereas the river discharge and tides act as a horizontal barotropic pressure gradient. The velocity profiles calculated by the analytical model suggest that the variation of baroclinicity over the spring-neap cycle is mainly caused by the horizontal density gradient.